A Tale of Two Sisters: Breast Reconstruction Options for Women With or at High Risk of Breast Cancer

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Abstract

Breast reconstructive surgery has changed significantly over the past decade. The incidence of nipple-sparing procedures and prophylactic mastectomy has also increased significantly as women and their surgeons use shared decision-making strategies. The following case history of two sisters, one with breast cancer and one at elevated risk for breast cancer, highlights the current standard of care with newer gold-standard procedures for mastectomy and subsequent reconstruction. A comparison of types of mastectomies, steps in reconstruction, and reconstruction options are discussed.

CASE STUDY

LM is a 51-year-old woman with a 4-cm infiltrating ductal carcinoma of the left breast. She is prediabetic but otherwise healthy. Family history includes breast cancer in her mother at 58 and "female cancer" in her maternal grandmother. Divorced, she worries about how this diagnosis and surgery will affect relationships, but she was not hesitant to proceed. She underwent neoadjuvant chemotherapy followed by a left modified radical mastectomy, sentinel lymph node (SLN) biopsy. Her margins were clear, and she had a negative SLN biopsy. Genetic testing revealed she is a *BRCA2* genetic carrier.

She opted for immediate breast reconstruction and had the standard placement of a tissue expander under her pectoralis muscle. The left chest was nearly flat at the completion of the procedure. Each week thereafter, she came to the plastic surgery office for fills of her tissue expander by the advanced practitioner who placed 60 to 100 cc of fluid each time via a needle through the chest skin. She stated that she had some discomfort with the expansions and usually avoided her normal activities for the next day or so, but then felt fine.

After two months, her expansion was complete and her next surgery to place a silicone implant was scheduled after a 1-month waiting pe-

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riod to allow the skin and tissues to adjust. Her second surgery consisted of removal of her expander and placement of a permanent breast implant. During the same procedure, she had a breast lift on the right in an attempt to give her symmetry. She had been offered prophylactic mastectomy on the unaffected side due to her *BRCA2* mutation carrier status, but declined. Her total time for breast reconstruction was 3 months. She recovered uneventfully, but states she is limited in her clothing choices since some reveal that the reconstructed breast is more rounded, and not a true breast shape. Because of this asymmetry, she avoids situations where she exposes her chest shape. She did not require radiation or additional chemotherapy, and has started tamoxifen.

Soon thereafter, her younger sister, SB, age 47, scheduled an appointment with her gynecology provider to discuss her options. Due to her sister's recent diagnosis and carrier status, she underwent genetic testing and was also found to be a carrier of the *BRCA2* mutation. Facing a nearly 70% lifetime risk for breast cancer (National Cancer Institute, 2019b), she wanted to be proactive and requested bilateral prophylactic mastectomies for risk reduction. She was referred to a breast surgeon and opted for nipple-sparing mastectomies. She desired immediate breast reconstruction, and to avoid the nearly 40% risk of nipple or skin loss, she was offered a staged immediate breast reconstruction, known as the Zenn Delay procedure.

After agreeing to quit vaping and all other forms of nicotine for at least 2 months prior to surgery and 2 months postreconstructive surgery, SB underwent bilateral nipple-sparing mastectomy with no implant or tissue expander placed during this initial surgery. She went home the next day with a drain tube and deflated breasts. She was comfortable, requiring no pain medication. Her drain tube was removed at 1 week and her final pathology showed no evidence of cancer. At 2 weeks, she returned to surgery for the bilateral Zenn Delay reconstruction, with reopening of her mastectomy incisions and placement of her final breast implants above her pectoralis muscles, supported with acellular dermal matrix. Implant size had been chosen by SB, and she chose to enlarge her breasts somewhat, which is safer for the skin to do after a surgical delay. She went home the same day of her reconstructive surgery, requiring no opioid pain medication. She was back at work 2 weeks after her reconstructive surgery, happy with her breasts, stating they are "better than the originals." The total time it took to complete her reconstruction was 2 weeks.

Of the nearly 270,000 new breast cancer cases diagnosed in 2019, nearly 80% will be invasive (American Cancer Society, 2019). In the 1970s, one of every eleven women was diagnosed with breast cancer, but currently, one of every eight American women will be diagnosed during her lifetime. Over 26,000 of these women are younger than 45 (North American Association of Central Cancer Registries, 2018). Furthermore, from 2005 to 2014, the receipt of breast reconstruction by postmastectomy patients rose from 33.2% to 60.0% (Epstein et al., 2018), while the index of disparity in all racial subgroups (except Native Americans) decreased from 51.4% to 22.6% for overall receipt of breast reconstruction. Of note, 90% of breast cancers are considered sporadic and not linked to hereditary susceptibility, while approximately 5% to 10% are associated with the *BRCA1* and *BRCA2* genes (American Cancer Society, 2017).

Generally, breast-conserving therapy is often preferred for appropriate candidates, since mastectomy does not give most women a better chance of long-term survival or a better outcome from treatment (Agarwal, Pappas, Neumayer, Kokeny, & Agarwal, 2014; Fisher et al., 2002). However, mastectomy may still be recommended for some women, such as those with larger (> 5 cm) or multicentric tumors. For these women, they are faced with both a cancer diagnosis and resultant loss of their breast, which is a significant body change. Breast reconstruction, an option for many women, can help address the potential feeling of disfigurement and sense of loss some women report (Holland, Archer, & Montague, 2016). This article seeks to review surgical and breast recon-

struction options for women with breast cancer or for nonaffected women who are at a significant risk for breast cancer and may be planning prophylactic mastectomy.

OVERVIEW OF BREAST CANCER SURGICAL TREATMENTS

For women with breast cancer, surgical options are often dictated by their tumor characteristics and potentially other recommended treatments. In general, many women are able to choose between breast-conserving therapy (lumpectomy followed by adjuvant radiation therapy) and mastectomy (with or without adjuvant radiation therapy), although most studies demonstrate that up to 60% of patients opt for breast conservation (Kummerow, Du, Penson, Shyr, & Hooks, 2015). From an oncologic perspective, most studies have demonstrated no survival benefit to mastectomy over breast-conserving therapy (Agarwal et al., 2014; Fisher et al., 2002). Regardless of the type of breast surgery elected, most women will also require some type of surgical nodal evaluation, such as a sentinel lymph node biopsy or an axillary lymph node dissection.

Studies in cancer patients have shown that about 50% prefer a collaborative role via information sharing and voicing some preference but relying on provider decision, and about 25% prefer a more active role, while another 25% prefer a passive role in the decision-making process (Singh et al., 2010). Shared decision-making is the preferred model per the American Society of Breast Surgeons when dealing with contralateral prophylactic mastectomy (American Society of Breast Surgeons, 2016). Some women will opt for a mastectomy to not only treat their current cancer, but also to prevent a second (new) breast cancer, particularly those with certain genetic mutations predisposing them to breast cancer (i.e., *BRCA1/2*) or strong family histories of breast cancer.

For women who undergo a mastectomy, the next step is deciding whether they are interested in breast reconstruction. Declining breast reconstruction, or "going flat" (see Figure 1) is becoming increasingly more popular (Rabin, 2016), as some women feel that the additional reconstructive surgery is too involved, takes too long, and increases their risk of surgical complications. And more

Figure 1. Going flat: Bilateral mastectomy without reconstruction.

women don't see it as necessary to quality of life or required for femininity (Steffen, Johnson, Levine, Mayer, & Avis, 2017). Nevertheless, many women still prefer to have some type of reconstruction (Miller, Steiner, Barrett, Fingar, & Elixhauser, 2017). As such, the type of mastectomy may vary based on patients' reconstructive preferences and/or breast anatomy. In general, there are three types of mastectomies: total mastectomy, skin-sparing mastectomy, and nipple-sparing mastectomy (Table 1). Any of these types of mastectomies can be performed with or without surgical lymph node evaluation. However, when a mastectomy is performed with an axillary lymph node dissection, it is called a modified radical mastectomy.

After mastectomy, most women experience numbness of the chest skin and/or reconstructed breast(s) that is often permanent. Other risks of surgery include bleeding, infection, seroma formation, need for additional procedures/surgeries, lymphedema, and/or cancer recurrence. Unfortunately, breastfeeding is no longer possible after any type of mastectomy, including nipple-sparing mastectomies. For women undergoing mastectomies, surgical drains are often placed and may remain for 2 to 4 weeks after surgery, which can result in additional complications. Given all of these considerations, the final surgical decision is ideally made as a collaboration between the breast surgeon and patient as well as the plastic surgeon, when applicable.

This comprehensive review of options is considered not only in cancer survivors, but in those women who have a genetic mutation that is associated with an increased lifetime risk of developing breast cancer (National Cancer In-

Table 1. Comparison of Types of Mastectomies

Mastectomy type	Breast removed	Skin removed	NAC removed	Reconstruction timing	Reconstruction options
Total mastectomy	Yes	Yes	Yes	Delayed	Implant-based or autologous tissue transfer
Skin-sparing mastectomy	Yes	No	Yes	Immediate[a]	Implant-based or autologous tissue transfer
Nipple-sparing mastectomy	Yes	No	No	Immediate[a]	Implant-based or autologous tissue transfer

Note. NAC = nipple areolar complex.
[a]May require intermediate step using a tissue expander prior to definitive reconstructive surgery with an implant or autologous tissue.

stitute, 2019a). Specifically, women who are genetic carriers of a *BRCA1/2* mutation or women whose lifetime risk of breast cancer is significantly increased due to a strong breast cancer pedigree, are receiving counseling about prophylactic mastectomies, often when nearing postreproductive age. These women may also proactively seek prophylactic surgery, as occurred in this case, in order to decrease their cancer risk, although sometimes body image and feelings of femininity can be adversely affected (Yao, Sisco, & Bedrosian, 2016).

BREAST RECONSTRUCTION: STATE OF THE ART AND SCIENCE

More than 50% of women with breast cancer and subsequent total mastectomy do not get reconstruction, either due to personal preference or simply not being offered the opportunity to undergo reconstruction (Reddy, Strassle, & McGuire, 2018). If a woman decides to "go flat," she may wear a breast prosthesis. But for those who do proceed, about 20% have autologous tissue transfer reconstruction (i.e., transverse rectus abdominis myocutaneous [TRAM], latissimus, or other flaps), and 80% have saline or silicone implant-based reconstruction (Schmauss, Machens, & Harder, 2015). Furthermore, since one of the goals of any reconstructive surgery is symmetry between breasts, unilateral reconstruction candidates may sometimes require reduction mammoplasty, breast lift, or breast augmentation to the unaffected side.

Specifically, breast reconstruction is a plastic surgery technique that recreates a breast mound, ideally to match an existing contralateral breast or to create two symmetric breast mounds. This can help physical well-being and balance, and some women report a sense of "closure" of their cancer treatments with reconstruction (Matthews, Turner, Williamson, & Clyne, 2018). In general, surgeons can use autologous tissue or prosthetic material to reconstruct the breast. Each of the options have advantages and disadvantages that the woman and her surgeon should deliberate in the shared decision-making process.

Implant-Based Reconstruction

The use of implants for breast reconstruction has stood the test of time and has been an option for women since the 1960s (Jones & Antony, 2019). While the implants themselves have improved over time, the real advantage of this technique is that all surgery is limited to the area of the mastectomy, and morbidity and downtime for the patient are much less than with other techniques. Classically, a woman would have a tissue expander placed under the skin at the time of mastectomy and undergo months of tissue expansion in the office before her final implant (see Figure 2). In the right-hand photo of Figure 2, she has received mastopexy to create breast lift by removing excess skin and tightening the surrounding tissue to support the breast. More recent techniques have evolved to allow more immediate placement of the final implant and superior cosmesis.

Some of these newer techniques include (1) nipple-sparing mastectomy, (2) support of the implant with acellular dermal matrices, and (3) fat grafting (Jones & Antony, 2019). The nipple-sparing mastectomy technique recognizes that there is often plenty of skin and a natural nipple

already present, so there may be no need to expand the skin and perform nipple reconstruction. Technical skills of the breast surgeon and technologies that help evaluate perfusion of the skin have contributed to make this type of mastectomy a reality for many women. Since new skin is not required, it decreases the need for expanders and tissue flaps that add skin for reconstruction. Acellular dermal matrices is cadaveric skin that has been decellularized. It supports the implant, avoiding unnecessary pressure on the mastectomy skin that could cause necrosis (Zenn et al., 2017). It also serves as a scaffold that revascularizes and is repopulated by the patient's own cells, forming a supportive and vascularized layer over the implants that increases their longevity.

A relatively new procedure, the Zenn Delay, widens the pool of possible candidates even further for these procedures by delaying the reconstruction for 2 weeks after the mastectomy (Zenn, 2018). By enhancing skin healing and regeneration, this allows the blood supply to improve and may mitigate many of the ischemic complications, such as nipple or mastectomy skin loss (see Figure 3). Many patients with previous surgery, previous radiation, or large breasts, who were sometimes excluded from immediate reconstructive surgery, may now be candidates for reconstruction. Finally, fat grafting involves liposuction of fat from elsewhere on the body, processing the cells, and then reinjecting them under the breast skin. The cells are alive, and this often adds softness and volume to the reconstructions, thus masking the implants whose seams may sometimes be obvious. In the future, this technique will likely advance enough that implants will no longer be needed, and breasts will be formed solely by grafted fat cells (Combellack et al., 2016).

Autologous Tissue Reconstruction

Pedicled Transverse Rectus Abdominis Myocutaneous (TRAM) Flap

This is a technique to move tissue from the lower abdomen to the chest to form breast mounds. Instead of an implant, the breast mound is created by shaping the skin and fat (see https://www.plasticsurgery.org/reconstructive-procedures/breast-reconstruction/animation). Since the lower abdomen has plenty of skin, this technique is advantageous when skin is needed for reconstruction, such as after a radical mastectomy or after the chest has been irradiated and the skin is of poor quality. Some women prefer their own tissue to synthetic implants and like the added benefit of a slimmer abdomen. This technique sacrifices the rectus muscle from its native location, but the tissue remains tethered to the body by the muscle and its blood supply. It is carefully moved to the chest through a subcutaneous tunnel and then used to recreate the breast mound. It is a tedious, 8-hour surgery, but long-term morbidity with this technique is low, unless bilateral reconstruction is needed and both rectus muscles are to be sacrificed (Schwitzer et al., 2015).

Free Transverse Rectus Abdominis Myocutaneous (TRAM) Flap

Instead of sliding the tissue flap still attached by muscle, the skin and fat of the lower abdomen and a small patch of rectus muscle can be completely detached from the body, moved to the chest, and then its blood vessels reattached using microsurgery. A large block of tissue that is completely detached from the body in this way is referred to as a "free flap." Since only a small amount of muscle is harvested with a free TRAM flap, the risk of significant long-term morbidity is lower and the recovery is easier than a standard pedicled TRAM.

Figure 2. Right breast postmastectomy with tissue expander followed by right nipple and areolar reconstruction, implant, and left breast lift procedure.

Figure 3. Nipple-sparing mastectomy by Zenn Delay procedure followed by implant insertion.

Deep Inferior Epigastric Perforator (DIEP) Flap

If possible, a free TRAM can be harvested without sacrificing muscle tissue, thus utilizing the perforating blood vessels that supply the skin and fat. This is called a perforator flap, based on the deep inferior epigastric perforators, hence the name DIEP (pronounced "deep") flap (Pien et al., 2016). These types of perforator flaps represent the state of the art in breast reconstruction.

Autologous tissue transfer reconstruction is a two-step process. The breast surgeon performs the mastectomy while the plastic surgeon completes their work during (1) a conjoined operation time (TRAM flap or latissimus dorsi flap, often an 8-hour procedure), (2) a delayed procedure (2 weeks post mastectomy with the Zenn flap), or (3) a few months post mastectomy when tissue expanders have been inserted and enlarged several times to prepare the skin to receive the saline or silicone implant. Table 2 provides a summary of common reconstructive surgery options.

CLINICAL IMPLICATIONS

This case of two sisters reveals legitimate concerns and decision-making by women with breast cancer and women at significant risk for breast cancer. It affirms evidence-based decision-making, including that breast conservation is often adequate and effective for smaller tumors, but there may be reasonable considerations for undergoing a mastectomy for cancer, or a mutation carrier status. Postmastectomy women have several breast reconstruction options, including implants and autologous tissue transfer. Future advances in techniques, such as fat grafting, are expected to develop for improved aesthetic results.

According to the National Comprehensive Cancer Network Guidelines (NCCN, 2019), postmastectomy women will need a screening mammogram every 12 months for the unaffected side but not the reconstructed breast, and an annual clinical breast exam of both breasts (NCCN, 2019). Furthermore, survivors often need support to continue their ongoing screening and medication adherence as well as suggestions for healthy lifestyle behaviors that will lead to improved breast cancer outcomes.

KEY RESOURCES

- Patients can find photos and personal stories of breast reconstruction procedures at http://breastreconstruction.org. All content has been edited by doctors on the Medical Board.
- The American Society of Plastic Surgeons has short videos of breast reconstruction options at https://www.plasticsurgery.org/reconstructive-procedures/breast-reconstruction.
- Plastic surgeons can be located at http://www.plasticsurgeons.org, the website of The American Society for Aesthetic Plastic Surgery.
- The NCCN Clinical Practice Guidelines in Oncology for Breast Cancer can be found at https://www.nccn.org/professionals/physician_gls/pdf/breast.pdf. ●

Table 2. Common Reconstructive Surgery Options

	Expander/implant	Abdominal tissue reconstruction (TRAM)
Surgery (excluding mastectomy)	One or two separate 1.5- to 2-hour procedures (TE vs. implant)	One 6- to 8-hour procedure
General anesthesia	Required	Required
Hospitalization	1 day with mastectomy, outpatient if done later	5–7 days with our without mastectomy
Scars	No additional scars	Additional donor site scar in the abdomen
Shape	No natural sag, improved projection	More natural shape and consistency (softer)
Contralateral breast	More changes usually required (lift, augmentation); best for bilateral	Less changes usually required; better match
Possible problems	Breast hardening with shape change (scarring); thinning of tissues over the implant (especially with radiation)	Abdominal pain, weakness or bulge (TRAM flap); long scars on the body at the donor site

Note. TRAM = transverse rectus abdominis myocutaneous; TE = tissue expander.

Disclosure

The authors have no conflicts of interest to disclose.

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